

REGULATION III - CONTROL OF AIR CONTAMINANTS

RULE 338 SEMICONDUCTOR MANUFACTURING

INDEX

SECTION 100 - GENERAL

- 101 PURPOSE
- 102 APPLICABILITY

SECTION 200 - DEFINITIONS

- 201 ACCEPTABLE TRACE VOC EMISSION
- 202 EMISSION CONTROL SYSTEM (ECS)
- 203 EXCEPTED CORROSIVE VOC
- 204 EXEMPT COMPOUNDS
- 205 FREEBOARD HEIGHT
- 206 FREEBOARD RATIO
- 207 NON-PRECURSOR ORGANIC COMPOUND
- 208 PHOTORESIST OPERATION
- 209 SOLVENT
- 210 SOLVENT CLEANING STATION
- 211 STRIPPING
- 212 VOC CONTENT OF MATERIAL
- 213 VOLATILE ORGANIC COMPOUND (VOC)

SECTION 300 - STANDARDS

- 301 CONTROL OF PHOTORESIST OPERATIONS
- 302 USING SOLVENTS CONTAINING MORE THAN 10 PERCENT VOC
- 303 OPERATION AND MAINTENANCE (O&M) PLAN REQUIRED FOR ECS
- 304 OPERATE CORRECTLY
- 305 STORAGE AND DISPOSAL OF VOC
- 306 EXEMPTIONS

SECTION 400 - ADMINISTRATIVE

- 401 COMPLIANCE SCHEDULE
- 402 CONTROL EFFICIENCY GENERALIZATION

403 APPLICABILITY OF RULE 331 FOR SUPPORT OPERATIONS

SECTION 500 - MONITORING AND RECORDS

501 MONITORING DEVICE RECORDS

502 RECORDKEEPING AND REPORTING

503 COMPLIANCE DETERMINATION

504 TEST METHODS

**MARICOPA COUNTY
AIR POLLUTION CONTROL REGULATIONS**

REGULATION III - CONTROL OF AIR CONTAMINANTS

**RULE 338
SEMICONDUCTOR MANUFACTURING**

SECTION 100 - GENERAL

101 PURPOSE: To limit the emission of volatile organic compounds (VOC) from semiconductor manufacturing.

102 APPLICABILITY:

102.1 This rule applies to making any semiconductor device, including diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices. This rule applies to all direct processing of the wafer/die from crystal growth and wafer production through oxidation, photoresist operations, etching, doping, epitaxial growth operations, circuit separation, encapsulation, and those assembly and test operations related to semiconductor manufacturing.

102.2 Rule 338 does not apply to an accredited school that has an educational program in which semiconductors are either fully or partially made. However, this rule is applicable to schools that sell such semiconductor constructions for other than teaching and/or research purpose(s).

SECTION 200 - DEFINITIONS: For the purpose of this rule, the following definitions shall apply:

201 ACCEPTABLE TRACE VOC EMISSION - Emission so dilute that less than 50 ppm or 220 mg/M³ registers on a VOC detector when its probe is 1 inch (2.5 cm) from the surface of a potential VOC-emitter. Such detector shall be used pursuant to subsection 503.5, using EPA Test Method 21.

202 EMISSION CONTROL SYSTEM (ECS) - A system, approved in writing by the Control Officer, designed and operated in accordance with good engineering practice to reduce emissions of volatile organic compounds. Such system consists of an emissions collection subsystem and an emissions processing subsystem.

203 EXCEPTED CORROSIVE VOC - The following compounds emitted either from photoresist process(es) or from semiconductor cleaning processes: citric acid, acetic acid, methylsulfonic acid, and tetramethyl-ammonium hydroxide. Also included are the following categories of corrosive VOC emitted either from photoresist process(es) or from semiconductor cleaning processes: acidic VOC emitted by any organic acid having a pH

of 2 or less in its most acidic aqueous state, and basic VOC emitted from a caustic organic solution having a pH of 12.5 or more in its most basic aqueous state.

204 EXEMPT COMPOUNDS - For the purpose of this rule, the non-VOC, non-aqueous evaporating portion of a formulation; this necessarily includes all non-precursor organic compounds in addition to inorganic liquids and gases.

205 FREEBOARD HEIGHT - The following measurement within the tank/basin of a cleaning machine, as determined during idling mode:

205.1 Batch:

- a. **Non-Vapor:** The vertical distance from the most elevated solvent surface to the least elevated point of the top-rim when the cover is open or removed.
- b. **Vapor:** The vertical distance from the least elevated point of the top-rim to the point halfway between the highest and the lowest point of the cooling coils.

205.2 In-line:

- a. **Non-vapor:** The vertical distance from the lowest entry/exit point to the most elevated solvent surface.
- b. **Vapor:** The vertical distance from the lowest entry/exit point, to the point halfway between the highest and the lowest point of the cooling coils.

206 FREEBOARD RATIO - The freeboard height divided by the smaller of the inside horizontal length or the inside horizontal width of the cleaning machine's evaporative surface area.

207 NON-PRECURSOR ORGANIC COMPOUND - Any of the organic compounds which have been designated by the EPA as having negligible photochemical reactivity. EPA designates such compounds as "exempt". A listing of the compounds is found in Rule 100.

208 PHOTORESIST OPERATION - A process for the application and development of photoresist masking solution on a wafer, including preparation (except primary cleaning), soft bake, develop, hard bake, stripping, and edge-bead removal, and can be generally subdivided as follows:

208.1 Negative Photoresist Operation: A process where the maskant hardens when exposed to light or other process radiation, and the unhardened maskant is stripped, exposing the wafer surface for etching.

208.2 Positive Photoresist Operation: A process where the maskant softens when exposed to light or other process radiation, and the softened maskant is stripped, exposing the wafer surface for further processing.

209 SOLVENT - Any liquid or vapor which is used to dissolve, clean, strip, or remove impurities, coatings, contaminants, or films from surfaces or from internal spaces and voids. This includes, but is not limited to, developers and stripping agents.

210 SOLVENT CLEANING STATION - A workplace equipped to remove surface contaminants using a liquid or vapor solvent containing volatile organic compounds. This excludes photoresist stripping processes.

211 STRIPPING - The removal of spent photoresist maskant from the product after etching, or the removal of oxide or other stencil agent from the product after diffusion, or any other removal of applied masking agent.

212 VOC CONTENT OF MATERIAL - The weight of VOC per volume of material and can be calculated by:

$$\text{Grams of VOC per Liter of Material} = \frac{V_s - W_w - W_{es}}{V_m}$$

Where: V_s = weight of all volatile compounds in grams, including water, exempt compounds, and dissolved vapors

W_w = weight of water in grams

W_{es} = total weight of all exempt compounds in grams

V_m = volume of material in liters

213 VOLATILE ORGANIC COMPOUND (VOC) - Any organic compound which participates in atmospheric photochemical reactions, except non-precursor organic compounds.

SECTION 300 - STANDARDS

301 CONTROL OF PHOTORESIST OPERATIONS: An owner or operator conducting photoresist operations at a semiconductor manufacturing facility that annually emits more than 25 tons (22.7 Mg) of VOC from all photoresist operations combined, measured prior to any emissions control, shall reduce photoresist VOC-emissions or aggregated VOC-emissions from both photoresist and cleaning-station processes using an ECS that satisfies the requirements set forth in either subsection 301.1 or 301.2 of this rule:

301.1 Use An ECS To Control Photoresist VOC Only:

- a. Achieve at least 80% overall VOC-control of photoresist VOC, including capture and processing of photoresist VOC, as determined by applicable provisions in Section 503; or
- b. The ECS shall capture at least 90% of all photoresist VOC and achieve an hourly average stack concentration not exceeding 20 mg VOC/standard cubic meter, as determined by applicable provisions in Section 503. Mass loading of VOC is expressed as milligrams of non-methane organic carbon.

301.2 Use An ECS To Control Aggregated Photoresist VOC And Cleaning VOC:

- a. Achieve at least 80% overall VOC-control of aggregated cleaning plus photoresist VOC, including capture and processing, as determined by applicable provisions in Section 503; or

- b. The ECS shall capture at least 90% of all cleaning and photoresist VOC emissions combined and achieve an hourly average stack concentration not exceeding 20 mg VOC/standard cubic meter, as determined by applicable provisions in Section 503. Mass loading of VOC is expressed as milligrams of non-methane organic carbon.

302 OPERATIONS USING SOLVENTS CONTAINING MORE THAN 10 PERCENT VOC:

302.1 Solvent Cleaning Stations: A person shall not operate a solvent cleaning station that cleans semi-conductor devices with solvents containing more than 10 percent VOC content unless each of the following requirements in subsections 302.1a through c are satisfied, or subsection 302.3 is satisfied.

- a. Each heated or unheated reservoir, sink, and container that transfers, stores, or holds VOC-containing material shall be provided with a full cover. A cover shall remain closed except while production, sampling, maintenance, or loading or unloading procedures require operator access; and
- b. All heated or unheated reservoirs and sinks holding VOC-containing materials with a total VOC vapor-pressure exceeding 33 mm Hg at 20°C (68°F) shall have a freeboard ratio greater than or equal to 1.0; and
- c. Solvent flow of VOC-containing materials shall be applied in a continuous unbroken stream and in a manner which shall prevent liquid loss resulting from splashing.

302.2 Cleanup Solvents: A person shall not use a VOC-containing material for the purpose of cleaning semiconductor manufacturing equipment at a semiconductor manufacturing facility unless the requirements in at least one of the following subsections 302.2a through 302.2c are satisfied, or an ECS is used pursuant to subsection 302.3. This includes, but is not limited to, the cleaning of empty boats, quartz tubes, and other devices used to hold, contain, or process semiconductors.

- a. The VOC content of the fluid does not exceed 200 grams per liter (1.7 pounds per gallon) of material; or
- b. The VOC composite partial pressure does not exceed 33 mm Hg (0.64 psia) at a temperature of 20°C (68°F); or
- c. The components being cleaned are totally enclosed during the washing, rinsing, and draining processes such that there are no greater than acceptable trace VOC emissions (ATVE) to the atmosphere during such processes. ATVE means that less than 50 ppm or 220 mg/M³ VOC is detected when determined according to subsection 503.5.

302.3 Alternative Compliance For Solvent Processes: An owner or operator of an operation is allowed to meet any and all provisions under subsections 302.1 and 302.2 that apply to that operation by:

- a. Using an ECS that achieves an overall control efficiency as required under Section 301 and that is operated pursuant to all applicable ECS requirements of this rule; or
- b. Using an Air-tight or Airless system that both is sealed during cleaning and drying and has a sealed, self-contained liquid-solvent recovery system; or
- c. Using only those materials in the operation that contain less than 100 g VOC/liter or no more than 10.0 percent VOC by weight.

303 OPERATION AND MAINTENANCE (O&M) PLAN REQUIREMENTS FOR ECS:

- 303.1** An owner or operator of a facility shall provide and maintain, readily available on-site at all times, (an) O&M Plan(s) for any ECS, any other emission processing equipment, and any ECS monitoring devices that are used pursuant to this rule or to an air pollution control permit.
- 303.2** The owner or operator of a facility shall submit to the Control Officer for approval the O&M Plans of each ECS and of each ECS monitoring device that is used pursuant to this rule.
- 303.3** The owner or operator of a facility shall comply with all the identified actions and schedules provided in each O&M Plan.
- 303.3** An owner or operator shall fully comply with each ECS O&M Plan that the owner or operator has submitted for approval, but which has not yet been approved, unless notified otherwise by the Control Officer in writing.

304 OPERATE CORRECTLY:

- 304.1 Process Equipment:** All active process equipment in which VOC-containing materials are used shall be operated and maintained in proper working order.
- 304.2 Leaks:** Liquids containing more than 0.2 percent VOC that leak at a rate of 3 drops per minute or more shall be repaired within 24 hours of detection, or the equipment shall be shut down until replaced or repaired according to the following schedule: Shut down prior to the next line shut down or within 24 hours of detection, whichever comes first.
- 304.3 Monitoring Devices:** Provide, properly install and maintain in calibration, in good working order, and in operation, devices for indicating or recording temperatures, pressures, rates of flow, concentrations or other operating parameters required by the O&M Plan for determining if air pollution control equipment or other means of control are functioning properly.

305 STORAGE AND DISPOSAL OF VOC:

- 305.1** All storage of VOC-containing materials subject to evaporation, including the storage of waste solvent and waste solvent residues, shall at all times be in closed containers, except when contents are added or removed.
- 305.2** Containers shall be legibly labeled with their contents.

- 305.3** Disposal of waste or surplus VOC-containing materials shall be done in a manner that does not promote VOC evaporation, such as, but not limited to, via sewage treatment works or having the waste hauled off-site in sealed containers.

306 EXEMPTIONS:

- 306.1 Quality Control And R&D Operations:** Except for this rule's Sections 304 and 305 and subsections 502.1 and 502.2, this rule shall not apply to those operations within a semiconductor manufacturing facility which are used exclusively for one or more of the following: chemical or physical analysis, determination of product quality or commercial acceptance, research, or pilot plant activities. Such operations may be exempted until the sum of daily emissions from all such exempted operations reaches but does not exceed 40 pounds (18.1 kg). This exemption shall not apply to a particular operation if the exemption is denied in writing by the Control Officer.

- 306.2** An aggregate of up to 55 gallons per year of material not exempted by other provisions within this Section 306 is exempt from the VOC-control requirements of Section 301 if usage is logged monthly in a coherent manner and cumulative usage is calculated.

- 306.3 Low VOC Materials:** The following provisions apply to materials with a VOC content of 10% or less as received by a facility; VOC content shall be determined pursuant to Section 503. Percent is either by weight or volume, as chosen by the operator.

- a. Materials with a VOC content of less than 2 grams VOC/liter or less than 0.2 percent VOC are exempt from Rule 338.
- b. Materials with a VOC content of 0.2% to 10% VOC are exempt from Sections 301, 302, 303, 501, and 502 of this rule if the total quantity annually received is updated annually pursuant to subsection 502.2c, and disposal is done pursuant to all requirements within Section 305.

306.4 Excepted Corrosive VOC:

- a. An excepted corrosive VOC is exempt from subsection 301.1 of this rule under the conditions in subsections (1) and (2) following:
 - (1) An owner or operator choosing the control option in subsection 301.1 is allowed to annually exempt an aggregated photoresist VOC total of up to 1 ton of excepted corrosive-VOC emissions from all control device and ECS requirements; and
 - (2) All excepted corrosive VOCs emitted in excess of the 1 ton (907.2 kg) per year aggregated allowance in 306.4a(1) are directed through a control device. No test of control efficiency shall be required for excepted corrosive organic compounds in a control device.
 - (3) All excepted corrosive VOCs emitted in excess of the 1 ton (907.2 kg) per year aggregated allowance in 306.4a(1) that are not directed through a

control device are subject to Section 301 and subsection 301.1 as ordinary, non-exempt VOC.

b. An excepted corrosive VOC is exempt from subsection 301.2 of this rule under the conditions in subsections (1) and (2) following:

(1) An owner or operator choosing the control option in subsection 301.2 is allowed to annually exempt from all control device and ECS requirements 1 ton of excepted corrosive-VOC emissions aggregated from photoresist plus semiconductor cleaning; and

(2) All excepted corrosive VOCs emitted in excess of the 1 ton (907.2 kg) per year aggregated allowance in 306.4b(1) are directed through a control device. No test of control efficiency shall be required for excepted corrosive organic compounds in a control device.

(3) All excepted corrosive VOCs emitted in excess of the 1 ton (907.2 kg) per year aggregated allowance in 306.4b(1) that are not directed through a control device are subject to subsection 301.2 as ordinary, non-exempt VOC.

306.5 Organic Silicon Compounds: VOC emissions up to an aggregated annual total of 1 ton of organic silanes and silicates, and any other organic compound of carbon and silicon, may be excluded by an owner or operator from being subject to the ECS control requirements of Section 301 if information from the manufacturer of the ECS indicates that such compounds adversely affect the operation of the model or type of ECS being used.

306.6 Wipe Cleaning: Wipe cleaning is not subject to Section 300, but the usage of VOC-containing solvent for wipe cleaning is subject to the recordkeeping provisions of Section 500.

SECTION 400 - ADMINISTRATIVE

401 COMPLIANCE SCHEDULE:

401.1 Effective Date: This revised version of Rule 338 becomes effective on June 1, 1999.

401.2 ECS Schedule: Any owner or operator of a facility first becoming subject to the ECS requirements of Section 301 or Section 302 and intending to install and commence to use an ECS to comply with Section 301 or Section 302, shall submit for the Control Officer's approval an emission control plan describing the ECS by the first day of the 4th month after the month in which such facility becomes subject to the ECS requirement. The plan shall show how the ECS is to be used to achieve full compliance. The plan shall specify dates for completing increments of progress, such as the contractual arrival date of new control equipment. The Control Officer may require a person submitting such emission control plan to submit subsequent reports on progress in achieving compliance. Any and all ECS used to achieve such compliance shall be in operation by 15 months after the facility becomes subject to the ECS requirement.

402 CONTROL EFFICIENCY GENERALIZATION: An owner or operator is allowed the following option:

402.1 You may calculate the processing efficiency of an ECS processing subsystem, operated pursuant to subsection 301.1a, that also optionally controls other VOC in addition to photoresist VOC, by assuming the same percentage efficiency as was calculated from testing the efficiency of controlling all input VOC. For example, if the capture/collection subsystem blends 150 lbs per hour of photoresist VOC with 50 lbs per hour of etchant VOC, and if the processor simultaneously reduces the 150 lbs of photoresist VOC to 15 pounds of VOC and 50 pounds of etching VOC to 3 lbs of VOC, the processor will be credited with reducing the photoresist VOC by 91% = $100\% \times \left[1 - \left(\frac{15 + 3}{150 + 50} \right) \right]$; not 90%.

402.2 In calculating the processing efficiency of an ECS processing subsystem operated pursuant to subsection 301.2a for an ECS that controls, in addition to cleaning and photoresist VOC, other VOC not addressed by subsection 301.2, it may be assumed that the ECS' efficiency for processing the aggregate of cleaning plus photoresist VOC is the same as that calculated from testing the efficiency of controlling all input VOC.

403 APPLICABILITY OF RULE 331 FOR SUPPORT OPERATIONS: The solvent-cleaning of equipment or parts that is performed for purposes other than semiconductor manufacturing shall be subject to the solvent cleaning Rule 331 of these Air Pollution Control Rules and Regulations.

SECTION 500 - MONITORING AND RECORDS

501 MONITORING DEVICE RECORDS: Keep and maintain monitoring records as required by the O&M plan.

502 RECORDKEEPING AND REPORTING: Any person subject to this rule shall comply with the following requirements. Records shall be retained for five years and shall be made available to the Control Officer upon request.

502.1 Current List: Maintain a current list of materials used in the manufacture of semiconductors: coatings, adhesives, maskants, solvents, cleaning solutions, and any other VOC-containing materials. State the material VOC content of each in pounds per gallon, grams per liter, or as a weight percent (percent by mass) of the material.

502.2 Usage Records:

a. Maintain monthly records showing the type and amount of all VOC-containing material used in semiconductor operations, except as modified by subsections b and c following. This includes, but is not limited to, strippers, maskants, solvent materials and cleanup materials.

b. **Grouping By VOC Content:** For purposes of recording usage, those maskants, strippers, coatings, solvents or other VOC-containing materials that are of similar type and similar VOC content may be given a group name and

recorded under that name. To the group name shall be assigned the highest VOC content among the members of that group, rounded to the nearest 10th of a pound per gallon, the nearest 1 g/L, or the nearest 1 percent. For each grouping, the name of each material in the group and its material VOC content must appear, along with the name of the grouping and its material VOC content.

- c. Update annually the usage of materials having a VOC content of 10.0% or less. The results of an applicable test method, referred to in Section 504, or data supplied by the material's manufacturer suffices to demonstrate VOC content of material for this purpose. If there is a discrepancy between the manufacturer's formulation data and the results of an applicable test method, compliance shall be based on the results from the test method analysis.

502.3 Records Of Disposal:

- a. The Control Officer may account as VOC emissions to the atmosphere such VOC as is not accounted for by an adequate demonstration of VOC recordkeeping.
- b. Emission factors acceptable to the Control Officer are allowed to be used in calculating VOC emissions.

502.4 ECS Recordkeeping:

- a. Make a continuous record of the times an ECS is used to comply with this rule.
- b. Maintain records of the O&M Plan's key system operating parameters with the frequency required by the Plan.
- c. Maintain records of all maintenance performed according to the O&M Plan.
- d. An explanation shall be entered for scheduled maintenance that is not performed during the period designated in the O&M Plan.

503 COMPLIANCE DETERMINATION: When more than one test method is permitted for a determination, an exceedance of the limits established in this rule determined by any of the applicable test methods constitutes a violation of this rule.

503.1 Sample Analysis: The following test methods shall be used for determining VOC content. For routine information collection, the Control Officer may accept a manufacturers data sheet (MSDS), data certified by an officer of the supplying company, or test data for the product model of inquiry.

- a. VOC content of materials having more than 10% solids by volume shall be determined using the applicable EPA Reference Method 24 or 24A (40 CFR, Part 60, Appendix A).
- b. The VOC content of solutions, dispersions, and emulsions that have no solids or less than 5% solids shall be determined by Method 31 of California's Bay Area Air Quality Management District (BAAQMD), or by California's South Coast Air Quality Management District Method (SCAQMD) 313-9.

- c. Solids-free solutions, in which all organic components are VOCs, may be tested using Maricopa County Reference Method #100, "Total Organic Carbon for Windshield Washer Fluids", Maricopa County Air Pollution Control Rule 344 (April 7, 1999).
- d. The VOC content of materials believed to have between 5 and 10% solids shall be determined by EPA Method 24, by BAAQMD Method 31, or by the SCAQMD Method 313-9.

503.2 Emission Testing: An ECS used pursuant to Section 301 and/or Section 302 shall be tested using EPA Reference Test Methods 18 or 25, or an applicable submethod of such Test Methods. VOC emission shall be measured and calculated as carbon.

503.3 Capture Efficiency: Capture efficiency of an emission control device used to meet the requirements of Section 301 or Section 302 shall be determined by mass balance in combination with ventilation/draft rate determinations done in accordance with subsection 503.4, or US EPA Test Methods 204, 204a, 204b, 204c, 204d, 204e, and 204f, Appendix M, 40 CFR 51. Verification that all active hoods and ducts, when measured at any selection of any interior place within them, are at negative pressure relative to adjacent, uncaptured air shall suffice for routine and uncontested demonstration of capture adequacy.

503.4 Ventilation/Draft Rates: Ventilation/draft rates shall be determined by EPA Methods 2, 2A, 2C, or 2D.

503.5 Determination of acceptable trace VOC-emission, with reference to subsection 302.2c, shall use a methane calibration standard. The detection instrument shall meet the requirements of EPA Test Method 21 (40 CFR 60). Use of the detection instrument shall generally meet the probe movement speed and probe orientation specifications of Method 21 for the exterior of piping, valves, tubing, connectors, and containers. Means other than described in Method 21 may be used for detector handling and positioning immediately above open liquids and within containers, ducts, and piping. A valid instrument reading under 50 ppm or 220 mg/M3 using a probe positioned closer than 1 inch also demonstrates acceptable trace VOC-emission.

503.6 Formula For Total Voc Vapor-Pressure: Equivalent to: **Voc Composite Partial Pressure**, with reference to Sections 301 and 302.

$$PP_c = \frac{\sum_{i=1}^n (W_i)(VP_i) / MW_i}{\frac{W_w}{18} + \sum_{j=1}^m \frac{W_{ej}}{MW_{ej}} + \sum_{i=1}^n \frac{W_i}{MW_i}}$$

W_i = Weight of the "i"th VOC compound in grams

W_w = Weight of water in grams

W_{ej} = Weight of the "j"th exempt evaporating compound in grams

MW_i	=	Molecular weight of the “i”th VOC compound in grams per gram mole, e.g., one gram-mole of isopropyl alcohol weighs 60 grams
MW_{ej}	=	Molecular weight of the “j”th exempt evaporating compound, e.g., 1 gram-mole of acetone weighs 58 grams; 1 g-mole HCl =36.5 g
PP_c	=	VOC composite partial pressure at 20°C in mm mercury (Hg)
VP_i	=	Vapor pressure of the “i”th VOC compound at 20°C in mm Hg
18	=	Weight of one gram-mole of water
n	=	Total number of different (dissolved) VOCs
m	=	Total number of different (dissolved) exempt compounds

504 TEST METHODS: The EPA test methods as they exist in the Code of Federal Regulations (CFR) (July 1, 1998), as listed below, are adopted by reference. The other test methods listed here are also adopted by reference, each having paired with it a specific date that identifies the particular version/revision of the method that is adopted by reference. These adoptions by reference include no future editions or amendments. Copies of test methods referenced in this Section 504 are available at the Maricopa County Environmental Services Department, 1001 North Central Avenue, Phoenix, AZ, 85004-1942.

504.1 EPA Test Methods:

- a. EPA Methods 2 (“Determination of Stack Gas Velocity and Volumetric Flow Rate”), 2a (“Direct Measurement of Gas Volume Through Pipes and Small Ducts”), 2c (“Determination of Stack Gas Velocity and Volumetric Flow rate in Small Stacks or Ducts”), and 2d (“Measurement of Gas volumetric Flow Rates in Small Pipes and Ducts”). All 4 of the foregoing methods are in 40 CFR 60, Appendix A.
- b. EPA Method 18 (“Measurement of Gaseous Organic Compound Emissions by Gas Chromatography”) and its submethods (40 CFR 60, Appendix A).
- c. EPA Test Method 21 (“Determination of Volatile Organic Compounds Leaks”) (40 CFR 60, Appendix A).
- d. EPA Test Method 24 (“Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings”) (40 CFR 60, Appendix A).
- e. EPA Method 25 (“Determination of Total Gaseous Nonmethane Organic Emissions as Carbon”) and its submethods (40 CFR 60, Appendix A).
- f. EPA Test Method 204 (“Criteria For and Verification Of a Permanent or Temporary Total Enclosure”), and related Methods 204a, 204b, 204c, 204d, 204e, and 204f (Appendix M, 40 CFR 51).

504.2 Other (Non-EPA) Test Methods:

- a. California’s Bay Area Air Quality Management District (BAAQMD) Method 31 (April 15, 1992), “Determination of Volatile Organic Compounds in Paint Strippers, Solvent Cleaners, and Low Solids Coatings”.

- b.** California's South Coast Air Quality Management District (SCAQMD) Method 313-91 (April, 1997).